MEMS based Meta-materials

Introduction

Resonance frequency of array of Split Ring Resonators (SRRs) depends on geometrical parameters like length, width, gap, distance between adjacent rings etc. and also on electrical parameters like mutual inductances, mutual capacitances and coupling strength between adjacent SRRs. Changing relative positioning of SRRs with respect to each other alters mutual inductances and coupling among the SRRs, consequently varying resonance frequency of system. Variation of relative positioning of SRRs dynamically may be achieved by fabricating SRRs on electrostatically actuated beams (for vertical displacement) or on a comb drive (for horizontal displacement).

Description

Figure 1 shows the schematic of the metallic SRRs under investigation. In this structure, the coupling between the adjacent rings is facilitated by the slits wherein capacitive coupling occurs.

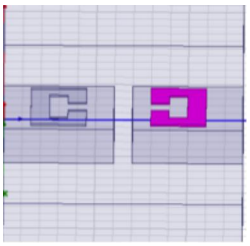

Figure 1. Schematic of a unit cell of SRR based metamaterial.

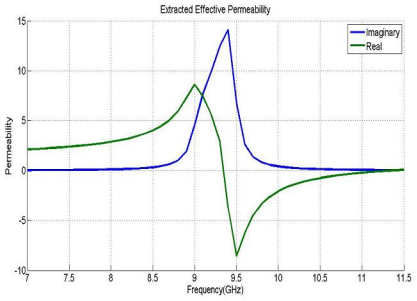

Figure 2. Schematic of a unit cell of SRR based metamaterial.

Figures 2 and 3 show the extracted effective permittivity and permeability from full wave simulations. It can be seen that at a frequency of 9.5 GHz for the SRR array considered here, the real parts of permeability and permittivity are both negative.

When the relative positioning between the adjacent SRRs, the coupling between them changes leading to a different resonance frequency. Figure 4 shows the shift in resonance frequency with horizontal displacement between two capacitively coupled SRRs. Current work involves fabrication and characterization of these structures and using MEMS based actuators for dynamically changing the horizontal and vertical displacements between SRRs.

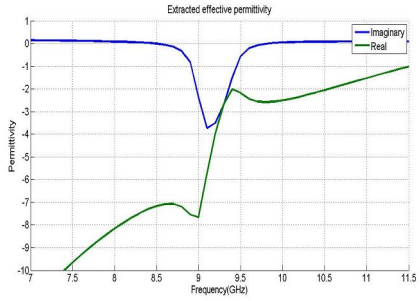

Figure 3. Schematic of a unit cell of SRR based metamaterial.

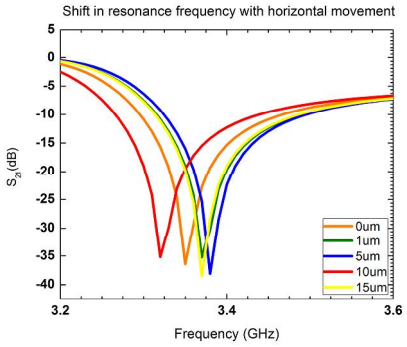

Figure 4. Shift in resonance frequency when SRRs are horizontally displaced with respect to each other.

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